**Research Note 2010-07**

# Mobile Learning Approaches for U.S. Army Training

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**August 2010**

**United States Army Research Institute**
**for the Behavioral and Social Sciences**

**U.S. Army Research Institute**
**for the Behavioral and Social Sciences**

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# REPORT DOCUMENTATION PAGE

| | | |
|---|---|---|
| 1. REPORT DATE (dd-mm-yy)<br>August 2010 | 2. REPORT TYPE<br>Final | 3. DATES COVERED (from. . . to)<br>Apr il 2010 to August 2010 |
| 4. TITLE AND SUBTITLE<br><br>Mobile Learning Approaches for US Army Training | | 5a. CONTRACT OR GRANT NUMBER<br><br>5b. PROGRAM ELEMENT NUMBER<br>A792 |
| 6. AUTHOR(S)<br><br>Jennifer S. Tucker (U.S. Army Research Institute) | | 5c. PROJECT NUMBER<br>633007<br>5d. TASK NUMBER<br>360<br>5e. WORK UNIT NUMBER |
| 7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)<br>U.S. Army Research Institute for the<br>Behavioral and Social Sciences<br>ARI – Fort Benning Research Unit<br>PO Box 52086<br>Fort Benning, GA 31995-2086 | | 8. PERFORMING ORGANIZATION REPORT NUMBER |
| 9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)<br>U. S. Army Research Institute for the Behavioral & Social Sciences<br>ATTN: DAPE-ARI-IJ<br>2511 Jefferson Davis Highway<br>Arlington, VA 22202-3926 | | 10. MONITOR ACRONYM<br>ARI<br>11. MONITOR REPORT NUMBER<br>ARI Research Note 2010-07 |

12. DISTRIBUTION/AVAILABILITY STATEMENT

Approved for public release; distribution is unlimited.

13. SUPPLEMENTARY NOTES

Subject Matter POC: Dr. Jennifer S. Tucker

14. ABSTRACT *(Maximum 200 words)*:

The purpose of this research was to review the current literature on mobile learning and identify potential approaches of incorporating smartphone technologies in US Army training. Specifically, the research reports successful demonstrations of mobile learning outside of the Army and identifies potential challenges in using the technology in Army training. Thus, the report discusses the following areas: Definition and potential advantages of mobile learning; Demonstrations of using mobile technology in instructional environments; Potential approaches for US Army training: A 5- to 10-year outlook; Challenges in using mobile learning technologies in US Army training; and Conclusions and research questions.

15. SUBJECT TERMS

mobile learning, training, blended learning, new equipment training, lifelong learning, Army Learning Concept

| SECURITY CLASSIFICATION OF | | | 19. LIMITATION OF ABSTRACT | 20. NUMBER OF PAGES | 21. RESPONSIBLE PERSON |
|---|---|---|---|---|---|
| 16. REPORT<br>Unclassified | 17. ABSTRACT<br>Unclassified | 18. THIS PAGE<br>Unclassified | Unlimited | 36 | Ellen Kinzer, Technical Publication Specialist<br>703.602.8049 |

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**August 2010**

**Army Project Number**
**633007A792**

**Personnel Performance**
**and Training**

MOBILE LEARNING APPROACHES FOR US ARMY TRAINING

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## Mobile Learning Approaches for US Army Training

The purpose of this research was to review the current literature on mobile learning and identify potential approaches of incorporating smartphone technologies in US Army training. Specifically, the research reports successful demonstrations of mobile learning outside of the Army and identifies potential challenges in using the technology in Army training. Thus, the report discusses the following areas:

- Definition and potential advantages of mobile learning
- Demonstrations of using mobile technology in instructional environments
- Potential approaches for US Army training: A 5- to 10-year outlook
- Challenges in using mobile learning technologies in US Army training
- Conclusions and research questions

Mobile learning technology includes many different types of wireless handheld devices, but the focus of this research will be on the use of smartphones for learning, although many of the prior lessons learned using wireless mobile devices come from work with personal digital assistants (PDAs).

### Definition and Potential Advantages of Mobile Learning

Mobile learning is the "exploitation of ubiquitous handheld technologies, together with wireless and mobile phone networks to facilitate, support, and enhance and extend the reach of teaching and learning" (Brown, 2010, p. 28). In contrast to distance learning or e-learning, mobile learning is shorter in duration, instantaneously usable, allows users to personalize content, enter data, and generate content (Brown). Mobile learning "focuses not on the learners and technologies but on the interactions between them, emphasizing that learning is a social process" (van 't Hooft, 2008, p. 13). Mobile learning provides digital content around which students engage and construct knowledge in a social manner (Brill & Park, 2008).

Mobile learning technologies may afford learners with more control and the ability to access, aggregate, create, and share information in a variety of media formats across space and time (van 't Hooft, 2008). Although there are many different types of mobile and wireless devices, they have commonalities such as:

- Connectability – connect to the Internet wirelessly via wireless fidelity (WiFi);
- Portability/wearability – always at the fingertips of the user;
- Instant accessibility – instantly turn on and off;
- Flexibility – collect data by accommodating a wide variety of peripheral extensions;
- Economic viability – have much of the computing capability and expandable storage capacity of laptops at a fraction of the cost;
- Social interactivity - collaboration, active participation, co-creation of knowledge, and critical reflection;
- Context sensitivity – ability to gather data unique to the current circumstance (location, time, etc.); affords access to authentic contexts;
- Individuality – flexibility for each individual to follow a self-directed, personalized, custom learning path (Brill & Park, 2008; Chuang, 2009; Dieterle, 2004 as cited in Dieterle, n.d.; Looi et al., 2009; Peters, 2007; Rogers & Price, 2008).

Many of the capabilities of smartphones that Soldiers use every day for personal use could be used for learning if included as part of instructional activities (pedagogy) designed for this purpose. The integration of Web 2.0 tools on smartphones may promote student-centered learning pedagogies (e.g., Cochrane & Bateman, 2010) and provide learners with more fruitful and effective relationships with their instructors and peers.[1] That is, Web 2.0 tools facilitate learners' creative practices, participation, production, and the exchange of experiences and ideas that ultimately result in the social construction of knowledge (Greenhow, Robelia, & Hughes, 2009; Pachler & Daly, 2009; The Horizon Report, 2008, 2009 as cited in Menaker & Tucker, 2010). The Army Learning Concept (ALC) also stressed the benefits of using Web 2.0 technologies such that "Soldiers are accustomed to connecting with peers across networks and have a habit of checking on buddies. The Army must leverage this capability to build dynamic vertical and horizontal social networks for formal and informal information sharing" (US Department of the Army, 2010, p. 16).

Activities requiring students to create their own knowledge about a content area also can be facilitated with the use of "wikis." Wikis are information pages about certain topics created from the input of many different people (e.g., Wikipedia). Knowledge can be co-created by students within a course as each person's contribution is edited and changed by the other people in the course; these activities may help students develop capabilities for knowledge representation, organization, sharing, and updating (Zhang, 2009 as cited in Menaker & Tucker, 2010). Social networking sites also allow students to collaborate with each other, receive feedback on each other's work, share information and resources, etc. Restricted networks more appropriate for classroom use can be established so that the students are only collaborating with each other and not the entire world as normally found on the Internet.

A review of the literature reveals very few examples of empirical research on mobile learning. Most reports are anecdotal in nature and based on case studies. Although there is a paucity of empirical evidence regarding the effectiveness of mobile technologies for learning, some survey and interview findings from instructors and students suggest benefits in terms of instructor workload and student outcomes. For example, giving more autonomy to learners in creating knowledge by finding the most appropriate resources for the task may reduce the pressures on instructors to constantly update traditional instructional materials to meet the unique needs of learners with diverse experiences.

Other reported benefits in terms of student outcomes include better acquisition of knowledge and development of higher-order thinking skills (critical self-reflection, analysis, and synthesis), higher levels of motivation, more engagement with peers, better attendance, preparation for class, participation in class activities, and self-directed learning, and a more collaborative relationship with the instructor (Murray, n.d.; van 't Hooft, 2008). A review by Vahey and Crawford (2002) of case studies from 102 instructors who were awarded grants from the Palm Education Pioneer program to use the wireless handheld technologies in their classrooms indicated that using handhelds increased students' self-directedness and initiative in learning, cooperation, collaboration and autonomy, and homework completion. In turn, teachers reported creating class activities that allowed students to work independently at their own pace, thus becoming more motivated and creative, improving their teaching of specific content, and decreasing the amount of wasted classroom time. Private industries also have reported positive outcomes associated with the use of smartphones for training such as reduced completion time, higher exam scores, and increased satisfaction (Brown, 2010).

[1] Web 1.0 tools focused on presenting information to users whereas Web 2.0 tools focused on providing social networking capabilities and instant self-publication.

Moreover, findings from a rigorous meta-analytic study conducted by the Department of Education (Means, Toyama, Murphy, Bakia, & Jones, 2009) suggest that the additional time on task required by distance learning (dL) instructional environments leads to better performance by students who take all or part of their instruction online compared to students in face-to-face instructional environments. Some interesting findings from case studies using the iPod indicated that students felt that the work was harder when using the iPod and that they were not performing as well as students in the other classes who did not have the devices (Murray, n.d). Both instructors and students felt that there was pressure on the students to accomplish the work differently, learn new skills quickly, and to engage in critical thinking. The instructors indicated that the students completed the work in alternate ways and that the use of the mobile technologies increased the level of higher-order thinking required by the students. Support for these findings may come from ideas such that publishing work to a peer audience motivates students to produce higher quality products (as reviewed by Looi, et al., 2009) and that when students write blogs they have to organize their thoughts, determine what matters, and communicate effectively (Schrum & Solomon, n.d.).

## Demonstrations of Using Mobile Learning Technology in Instructional Environments

There are many academic case studies from K-12 classes and university settings that report some possible benefits of mobile learning afforded by Web 2.0 capabilities, including podcasting, vodcasting, geolocation, prototyping of animations, and user content creation tools (e.g., Cochrane & Bateman, 2010; Kolb, 2006).[2] A central theme from all of these case studies is that by using these tools students can easily work together to share and create knowledge. For example, students can work independently on projects and document their progress with blogs in which their peers can read and provide feedback (e.g., Twitter). Students can add digital pictures and short video clips taken with smartphones along with geotags (i.e., locations of events on Google Maps) to written narratives to enhance their work (e.g. Cochrane & Bateman). There are many Internet sites that facilitate the storing and editing of audio and video clips.

One example of using mobile technologies for learning is the documentation of student work throughout a design project (e.g., Cochrane & Bateman, 2010). Design instructors often comment that when students turn in final products they typically cannot articulate the changes which occurred in their thinking throughout the design process resulting in modifications to the products. In contrast, one student took pictures and short videos of his work throughout the design project and posted them on a blog. He then edited the clips and created a final video that showed all the key changes throughout the process. The student indicated that these tools allowed him to document his thought processes so that he could reflect better on the decisions he made throughout the project. Similarly, some instructors require students to create e-portfolios of their work so that progress and change can be documented throughout the class project. Smartphone capabilities allow students to create journals with pictures, videos, and geotags and integrate these into a portfolio that can be shared with peers and the instructor.

A few case studies reported the use of geolocation to provide individuals with contextualized learning (e.g., Meyer, 2009; So, Seow, & Looi, 2009; van 't Hooft, 2008). As

[2] In this section, most case studies using Web 2.0 and other smartphone technologies are from K-12 classes and included a range of academic disciplines such as science, math, history, English, English literature, English as a Second Language, art, social studies, language, music, and special needs. Universities have typically used podcasting for lecture-based classes or used smartphone technologies to provide text-based information to students. Notable exceptions are from universities outside of the United States and include academic disciplines such as product design, architecture, music, art, and landscape design.

individuals approached certain locations, they automatically received information in the form of pictures, videos, text, web-based information (Internet links), etc. regarding that location. Learners also used Google Maps to enhance their learning experiences by marking the locations on maps, including their own notes, pictures, hyperlinks, etc., and then sharing these with their peers (So et al., 2009). Their peers in turn provided feedback and added notes, asked questions, clarified answers, etc. Thus, learners socially constructed meaning by asking questions, making suggestions, and giving comments about the information (So et al., 2009).

When peripheral devices are attached to wireless handheld devices (examples are from use with PDAs), other types of student activities were developed such as running experiments and collecting and reporting data (case studies were from a range of scientific areas including chemistry, biology, physics, etc.; for a review see Rogers & Price, 2008 and Vahey & Crawford, 2002). Students often worked in groups to record and analyze the data and present the results. Immediate feedback in terms of measurement readings etc. allowed students to make different predictions and generate new hypotheses throughout the projects (e.g., Rogers & Price, 2008).

## Potential Mobile Learning Approaches for US Army Training: A 5- to 10-Year Outlook

### Blended Learning Approaches for a 5-Year Timeframe

For Army institutional courses, mobile learning activities may be more easily implemented as blended learning approaches. Blended learning instructional approaches are defined as those which combine different training media (technologies, activities, types of events) to create an optimum training program for a specific audience (Bersin, 2004). For example, in the Infantry Officer Basic Leadership Course (IBOLC), new lieutenants are required to develop platoon operations orders and brief the orders to their instructors and peers. Currently, the lieutenants work on their orders independently and receive summative feedback from the entire class and their instructors. If the students had smartphones, this activity could be restructured so that students could blog about their ideas and progress on their orders and receive formative feedback from their peers. Students also could use a smartphone application (app) to draw the graphics for their orders and share them with their peers and receive immediate feedback. Students also could send each other links to information on the Internet. Receiving feedback from instructors and peers many times throughout an activity promotes knowledge acquisition and learning in a much more profound way than receiving feedback at only one time on the final product. As laptop computers are not provided due to cost, smartphones may be a more cost effective way to provide lieutenants with a way to collaborate with their peers and co-construct knowledge. Research is needed to determine both the effectiveness and cost savings of using smartphone technologies as part of a blended learning program of instruction (POI) in US Army training courses. Research also is needed to determine whether a mobile device is the right tool for a particular learning objective.

Further, the use of geolocation and geotagging on smartphones could enhance the effectiveness of the instruction in Army courses and promote learning. Building on the example above, much of the IBOLC training occurs in the field. Thus, new lieutenants are given missions that occur in the context of a local training area. If smartphones were provided as part of these activities, then as the lieutenants planned to execute the mission (e.g., while performing a leader's reconnaissance), they could automatically be provided with information regarding certain aspects of the mission from the instructors role-playing the company commander and battalion staff members. Including this type of interactivity with technology and the receipt of additional information in the training would have to be in line with the conduct of a real mission (i.e., follow doctrine); however, it is plausible that leaders receive updated intelligence about the target throughout the planning process. Moreover, as there are limited opportunities in the training context for the lieutenants to perform leadership roles during field exercises, all students in the class would greatly benefit from participating in activities that allow them to share some of their ideas about the mission and receive feedback from peers without affecting the assigned leader's performance. The use of blogs and Google Maps could allow the students to share information during mission planning that would not interfere with the assigned leader's tasks.

There are many Army courses that also could potentially benefit from smartphones if peripherals were developed to help students learn the procedures of certain tasks more effectively and efficiently. For example, mechanics, engineers, information systems operators, explosive ordnance disposal specialists, etc. are required to take courses in which they learn how to use the tools of their Army military occupation specialties (MOSs). Peripherals could be developed that simulate the functions of these tools for advanced individual training (AIT) courses (courses designed to develop MOS-specific skills following basic training). The smartphones with these peripherals could download data for students to immediately analyze and receive feedback. Obviously students need to learn how to use the real tools appropriately but cost savings might be realized by using these applications to solve problems, troubleshoot, etc. in the context of a blended learning environment. As indicated above, research is needed to compare the use of smartphone technologies in this manner with the current POIs to determine both skill acquisition / retention and cost effectiveness.

Additionally, interesting uses of wikis can be thought of for both junior and senior-level Army institutional courses. For example, if Soldiers were provided with smartphones for use throughout initial entry training courses, they could be required to create wikis of many different Army topics (Army values, customs and courtesies, etc.). All students in the course could add and edit the information, and then they could post questions and have discussions regarding the topics via blogs and restricted social networking sites. Instructors would need to comment on the blog discussions and answer certain questions in a face-to-face forum. For more senior-level courses, such as the Maneuver Captains Career Course, wikis also could be created for many different topics covered in the course. For example, during one part of the course, the students are tasked to perform the duties of different battalion staff positions. The students could be asked to develop wikis of these different positions, and as the students have different backgrounds and experiences, the information about these positions will vary from class to class. Students could further share their experiences in these roles via blogs and restricted social networking sites.

Incorporating activities facilitated by smartphone technologies in POIs as hip-pocket training to fill down-time in courses also could be a fruitful blended learning approach for Army institutional courses. As the logistics of moving large numbers of leaders and Soldiers to and from and through field exercises creates downtime in institutional courses, learning activities developed to utilize smartphone technologies could provide Soldiers with additional training opportunities. For example, while Soldiers in initial entry training courses await their turn on the firing line to group, zero, and qualify with their assigned weapon, they could interact with an app specifically designed to enhance marksmanship skills. Additionally, as officers are transported to a field exercise, they could review their plan of the mission, give and receive feedback from peers, or review supplemental information regarding the upcoming exercise. After the field exercise, they could blog or chat with their peers regarding different points of the exercise and share lessons learned. Further, as after-action-reviews (AARs) are typically performed at the training site with typically limited access to note-taking materials, officers could more immediately record this feedback (instead of waiting to make notes in the garrison / company area), note how they would have changed their plan based on the outcomes of the exercise, and keep these notes for future reference.

**Smartphone applications.** Another potential benefit of using smartphone technologies for Army training is the ability to run software programs in the form of *apps* on the devices. There are three categories of apps that could be especially relevant for Army training. First, knowledge apps are probably the most common and include familiar training content such as job aids [MEDEVAC 9-line (medical evacuation), marksmanship zeroing information, planning

templates, course content (operations orders, exercises, information on weapons, first aid, etc.), and graphics (Army symbols, terrain information, etc.).

The second type reflects interactive apps that can either be developed as stand-alone training exercises or as supplemental activities for larger training exercises. For example, scenario-based leader training has been converted to a mobile device which allows leaders to view videos and respond to questions throughout the exercise. However, other types of apps, utilizing built-in smartphone technologies, could supplement field training exercises. For example, smartphones have built in accelerometers (ability to detect and respond to motion) and Global Positioning Systems (GPS, context aware-orientation, location, etc.). These capabilities could be used when conducting training in many different areas such as terrain analysis, convoy operations, urban operations, explosive ordnance disposal training, marksmanship training, etc. Research is needed to determine the potential benefits of using these applications either as simulated training exercises or as part of a blended learning approach for field exercises.

The ability to include videos, graphics, audio, textual information, and simulation capabilities (semi-automated forces, etc.) in combination with context-aware information further extend the possibilities of how smartphones could be used in Army training. For example, research is being conducted with augmented reality apps; these are mobile games which take into consideration the user's position and surroundings. Individuals interact at the same time with the virtual world and the real world; user actions in the real world have an effect in the virtual world (Lavin, Torrente, Moreno-Ger, Vallejo-Pinto, & Fernández-Manjón, 2009). As the learner is participating in the simulation, the simulation is adapting and changing the scenario based on the context-relevant information provided by the technology. Thus, immersive simulation technology in which the individual is in a complete virtual world (either physically as in enclosed simulated environments or computer-based as in Second Life) may not always be necessary to obtain the benefits of simulation-based training.

Phillips, Ross, Lickteig, and Livingston (2009) noted the benefits of an augmented reality approach for counterinsurgency (COIN) training such that training environments could be created that are physically and cognitively authentic beyond what is currently possible. Scenarios aimed at honing complex decision making skills incorporate the authentic situational cues and factors of the physical environment; however, the technology that is overlaid on the physical terrain allows the same training range to be effectively utilized again and again. Although by using augmented realty apps any physical environment could be potentially transformed into a learning situation, some training content would only best be simulated in certain contexts and under the supervision of an instructor. Research is needed to determine the effectiveness of different simulation contexts for different tasks, MOSs, echelons, etc.

Although there are many possibilities for how these types of apps may be used for Army training, one app in particular may benefit leader training programs. Specifically, most leader training programs have the limitation of only being able to rotate a few individuals into leadership positions during training exercises. All of the other students in the class have to fill the other positions in the platoon, company, etc. Thus, the individuals become training aids for these missions as they fulfill the roles of squad leaders, platoon/company members, battalion staff members, etc. An augmented realty app could simulate all of these other positions and allow every student the opportunity to lead in a field setting. All students could then be afforded the opportunity to practice leadership skills the field. The app could potentially allow them to interact both in the virtual world with their augmented unit and in the real world with the physical setting, the instructor, and their peers. Another example of utilizing these capabilities would be

to modify training materials previously developed to hone certain skills such as terrain analysis (e.g., Rossi, Khan, Nanda, Lickteig, Schaefer, 2009). These materials could be modified with the use of an augmented reality app that situates the training scenarios in real physical contexts.

The third type reflects sensory apps including face recognition, fingerprint authentication, motion sensors, physiological indicators (e.g., heart rate, glucose), etc. These types of apps may have the potential to enhance training scenarios. As similar tools are available in operational contexts, the standing operating procedures (SOPs) in collecting, storing, analyzing, and transmitting these data could be trained in the context of a larger scenario. For example, conditions in the current operating environment (COE) have required junior leaders to collect information from the local population, and it is likely that these leaders received little training on data collection and management. Use of these tools in a training environment could allow for more robust training scenarios requiring Army leaders to execute all of the SOPs for certain conditions. Furthermore, physiological apps could add a sense of realism and authenticity to training scenarios aimed at strengthening first aid skills. For example, these apps may provide a cost benefit when training combat medics and other medical personnel when learning first aid treatment. That is, the students could be afforded with multiple opportunities to practice techniques using first aid simulations on smartphones (e.g., interacting with avatars to diagnose medical conditions) before practicing the techniques using the real equipment. Research is needed to determine the potential benefits of developing simulation-based training on smartphones and to determine whether the additional practice opportunities promote the acquisition and transfer of task-based skills.

**Training Approaches for a 10-Year Timeframe**

**Lifelong learning.** To support a paradigm / culture shift in the way that the Army initially trains its leaders and Soldiers and maintains these skills throughout their lifetime, smartphones could be thought of as standard issue along with uniforms and protective gear. Drill Sergeants could start the lifelong learning process by making Soldiers accountable for the phones, loading the phones with training materials for use while in initial entry training courses, teaching Soldiers how to communicate with their peers, and using the Web 2.0 technology to enhance learning activities. Institutional instructors could continue the learning process with these technologies by adding new training content / apps on the smartphones when Soldiers enter AIT courses, professional military education (PME) classes, or specialty schools. Further, unit leaders and trainers could incorporate the use of smartphones into their collective training exercises; specially designed apps could be developed to enhance collective field training exercises. Finally, leaders and Soldiers could take responsibility for their own lifelong learning using smartphones by downloading new training material when they are promoted, enter a new unit, etc. Web 2.0 technologies could provide leaders and Soldiers with resources by keeping them connected with each other after they leave training courses and by allowing them to network with Army members to discuss issues they might have throughout their careers. Finally, these technologies offer Army leaders of both institutional and operational units critical information regarding leaders and Soldiers as they progress through their careers and from one training program to another.

These ideas are supported by the Army learning model presented in a recent draft of the ALC (US Department of the Army, 2010). Specifically, the ALC's objective is

> a learning continuum that blurs the lines between the operating force and the generating force by meshing together self-development, institutional instruction and operational

> experience. This is a learner-centric continuum that begins when one joins the Army and does not end until retirement. (p. 1)

The ALC emphasizes a goal to provide training materials to leaders and Soldiers “at the point of need” throughout their careers. “Providing mobile internet devices as part of a Soldier’s kit will facilitate this emerging style of communication and collaboration” (US Department of the Army, 2010, p. 16).

The idea of lifelong learning is not new to researchers of academic and private industry contexts and has been defined as essential for training a workforce capable of adapting in a rapidly-changing world (cf., Sharples, 2000). Given that it is not possible to equip leaders and Soldiers with all the knowledge and skills needed to be adaptive and high performers from any one institutional course, a series of PME courses, or from unit or new equipment training (NET) alone, equipping leaders and Soldiers with smartphones may help them manage their own learning in a variety of contexts throughout their professional careers (cf., Sharples, 2000). The use of smartphones in this way may help foster capabilities between the Generating Force and the operational Army such that the development of long term projects may help leaders and Soldiers to better understand how knowledge and skills can be applied in a range of contexts (cf., Vahey & Crawford, 2002). That is, mobile learning may create more of a seamless learning experience between formal (course-based) and informal (self-development) learning activities (Looi et al., 2010). Further, the implicit accountability of having a single device to store, track, and complete assignments may result in a greater sense of responsibility for one’s own learning especially when the limitations of having to attend brick and mortar classes during specific timeframes are removed (cf., Vahey & Crawford).

**New Equipment Training (NET).** NET is defined as “training to prepare commanders, leaders, trainers, users, and maintenance personnel during development and fielding of new equipment” (Dyer & Tucker, 2009, A-12). Smartphones in a NET context would most likely best be used to provide either prerequisite training on knowledge and skills needed to successfully learn and use the new equipment (previously these materials were delivered to units on cds; US Army Research Institute, 2003) or post-training materials and exercises to sustain the skills developed in NET. Reports from prior observations of NET and results of Soldiers’ performance suggest that Soldiers need instructor demonstrations of each procedure accomplished with the new equipment and many opportunities during NET for hands-on practice with the actual equipment (i.e., field exercises with the platoon/company) to gain the full benefits of NET (Dyer & Tucker). In summary, the use of smartphones pre-NET could provide Soldiers with the requisite knowledge to quickly acquire the skills for the new system. Use of smartphones post-NET could reinforce/maintain these skills and could allow Soldiers to share lessons learned from using the equipment with other operators. It is important to note, however, that the use of smartphones for these purposes would only be feasible if the Army adopts the technology as one strategy for supporting lifelong learning as described by the new Army learning model (cf., US Department of the Army, 2010).

## Challenges in Using Mobile Learning Technologies for US Army Training

### Student Training Requirements

Researchers reporting the results of case studies using smartphones and other wireless handheld devices for learning indicate that developing students' abilities to use the technology for learning requires special attention and time. "Although students may be adept at using digital technologies for entertainment, the literacy demands [increased collaboration and networking] that are placed on them when using these same technologies are very different" (van t' Hooft, 2008, p. 16). For example, although Soldiers may use Web 2.0 technologies, such as blogs, for personal use, they may need assistance in developing effective learning strategies to attain the potential benefits from using these same technologies in a learning context (e.g., Cochrane & Bateman, 2010; Rogers & Price, 2008).

### Design Requirements and Development

Smartphones offer leaders and Soldiers the ability to receive training in modules or lesson chunks. Army leaders and Soldiers may not have time for 40-minutes worth of training but could squeeze in 10-15 minutes of training throughout the day either on or off duty (see Boehle, 2009 for examples of industry training with Blackberries). The ability to receive training in chunks and the capability to bookmark courseware so that learners can time their own chunks and come back to exactly where they left off highlights one advantage of using smartphones for training (Boehle, 2009). The ALC also indicates that "distributed learning content will be packaged in short modules that fit conveniently into a Soldier's schedule" (US Department of the Army, 2010, p. 15).

To support the notion of anytime/anywhere training, training modules/lessons could be designed so that they can be downloaded onto the smartphone and accessible from the device's hard drive without having to connect to the Internet (Boehle, 2009). When Soldiers are on extended training exercises they may not have Internet access, however, they still need the ability to access the training materials from the device. This capability would only be appropriate for activities that would not require Internet resources to complete. Further design considerations are the following:

- Design content for smaller screens (Boehle).
- Choose the right interactions (drag/drop; complete sentences; pull-down; Boehle, 2009).
- Storage capability (although most smartphones come equipped with large storage capacity).
- Creating generic learning materials for all mobile phones is not effective; materials need to be specific to the capabilities of the phones being used – carriers control proprietary features without permitting other carriers to exchange information with each other (cf., Brown, 2009).
- May want to have a groupware system where one screen receives input from multiple devices to permit multi-user operation; facilitates group learning portfolios (Yang & Lin, 2010).
- Mobile learning technologies may only be effective as learning tools if developers understand their strengths and weaknesses and incorporate them into appropriate pedagogical practices (Motiwalla, 2007).
- Need projected keyboard or perhaps keyboard on iPad for extended writing (cf., Vahey & Crawford, 2002).

- New technology is being developed to allow devices to project a virtual keyboard and a large screen image for better use and visual display (Motiwalla, 2007).

- Apps that facilitate group work so that individuals don't have to go through third party connections to send work quickly; decrease the number of steps for learners to collaborate (e.g., reduce the need for usernames). Apps also should allow for broadcast messages to the entire class or to an entire group of students. This is possible with e-mail but typically group e-mail settings have to be created – of course students also could use blogs, instant messages, and social networking sites.

Regarding the development of smartphone technologies, Web 2.0 capabilities are already available. Instructors need training on how to develop a blended learning curriculum utilizing these capabilities. After becoming comfortable with using the technology in Army courses, leaders and Soldiers may develop their own learning strategies for using the smartphones. These in turn would become lessons learned for instructors that could be shared with future students. In the review of 102 case studies, Vahey and Crawford (2002) indicated that "students were very comfortable using handheld technology and that in many cases, students took the lead in developing ways to use handhelds for learning" (p. 28).

On the other hand, the development of software apps will have to be a joint venture with contractors who possess information technology (IT) knowledge or with dedicated Army personnel who have these skills. The many resources and free authoring tools available to develop the software would allow individuals without extensive IT experience to build training apps with the exception of the augmented reality mobile games. However, limited resources (i.e., time, manpower) within institutional and US Army Forces Command (FORSCOM) units would not make it feasible to task course managers/instructors and training developers with the responsibility for developing knowledge, interactive, and sensory apps.

Moreover, a new system that is flexible, timely, and effective must be created to test and release the apps. As new ideas for training apps will likely be continuously suggested by leaders and Soldiers, existing apps will quickly become obsolete. Thus, once apps are developed they should be made available to instructors and students as soon as possible. In the past, it took dL content created for Army institutional courses two years to be tested and approved, resulting in entire dL courseware that was obsolete at the end of the process. A new system has to be developed that gives unit leaders more control over the development and testing process. Pilot testing of the apps with instructors and current students and a spiral development approach that modifies the technology based on user input is a reasonable and sound approach that is flexible, timely, and effective. In summary, for apps used as part of a blended learning approach in existing classes or used as part of unit training, course developers/instructors and unit leaders should be the managers of these technologies. On the other hand, apps that are developed for lifelong learning would need a different development and management approach. The US Army Training and Doctrine Command (TRADOC) would likely be the managers of these types of apps; however, design and development of the content would need to occur with the collaboration and input of institutional and FORSCOM unit leaders. Research is needed to determine an effective model for developing apps – especially more complex software such as augmented reality apps.

**Instructor Training Requirements**

Higher student motivation and engagement with the use of mobile technologies has been attributed to several factors including learner control, learning-in-context, continuity between contexts, replication of natural settings, and communication (for a review see McGowan, 2009). These factors may be attributable to instructional techniques that draw more from problem-based learning approaches in which the learning of individual concepts and procedures occurs within the context of a problem (for a review see Duffy & Raymer, 2010a, 2010b) than from direct instruction approaches. As indicated in the ALC,

> engaging the learner in collaborative, problem solving exercises that are relevant to their work environment provides an opportunity to develop critical 21st Century Soldier Competencies such as initiative, critical thinking, teamwork, and accountability along with specific knowledge content. This problem-centered instructional approach encourages peer-to-peer learning and puts the instructor in the role of a facilitator who supports learning through guided questioning to elicit active student participation in the learning process. (US Department of the Army, 2010, p. 13)

Moreover, in adopting these instructional approaches, the amount of face-to-face interaction in Army courses may be reduced but the quality may be potentially increased with a richer, socially supported learning experience (US Department of the Army, 2010).

Although problem-based learning approaches are difficult to design and execute in Army training, in part due to the challenges of changing from direct instruction techniques and to the resources needed to create the training materials, the use of smartphones could facilitate the use of these techniques. For example, interactive apps could be developed for the problem-based scenarios, and students could access information on the Internet to help them navigate through the problem. Students also could utilize all of the Web 2.0 capabilities to co-construct knowledge regarding the problem, thus possibly enhancing their individual performance on the learning tasks.

It is important to note, however, that instructors will need support (time and resources) to create activities appropriate for mobile learning (activities that promote greater learner autonomy and independence) and to integrate these activities into a blended learning curriculum. Additional time is needed to both repurpose traditional instructional approaches and content so that it can best be used via technology *and* to repurpose technological tools that were not originally developed for education to best be used by students in a learning environment (Mishra & Koehler, 2009). “Pedagogical integration of m-learning into a course or curriculum requires a paradigm shift on behalf of the lecturers involved, and this takes significant time” (Cochrane & Bateman, p. 11).

Taken together with the smartphone technologies, the development of mobile learning activities can be guided by the following pedagogies and functions:

- Problem-based learning / deep learning: activities requiring students to navigate, sort, organize, analyze, and make graphical representations;
- Making things visible and discussable: activities requiring students to express ideas through photography, graphical representations, modeling, animation, and digital art;
- Sharing ideas/building community: blogs, wikis, and virtual worlds;
- Collaboration: use of Internet applications to plan and write together;
- Research: use bookmark tagging tools and citation engines to organize what is needed form the Web;
- Project management: provide web space for students to store work sources, feedback from peers, drafts, and products; and
- Reflection/iteration: shape and revise work and obtain critical feedback from others (Boss & Krauss, 2007).

Finally, there is a rich history and an abundance of case examples of podcasting in which *instructors* have used podcasts to reformat their lectures so that students can view them anytime/anywhere or have used PDAs to post class information and content (e.g., for a review see Gkatzidou & Pearson, 2009 and Kim, Mims, & Holmes, 2006; McKinney, Dyck, & Luber, 2009). However, to fully benefit from smartphone technologies, *students* should construct outputs and share them with their peers and instructors. This would better promote a Web-based participatory culture that supports a collaborative learning environment (e.g., Cochrane & Bateman, 2010; Menaker & Tucker, 2010).

**Sequencing / Scaffolding within Army Courses**

When redesigning curriculums to include smartphone technologies, instructors will need to consider the sequencing of mobile learning activities. The sequencing will depend on which pedagogies/instructional techniques are adopted by the instructor. If a problem-based learning approach is followed, then the instructor may begin the course by presenting a scenario-based problem to the students and requiring the students to formulate an initial plan to solve the problem. The instructor may further require the students to document the progress of their work using Web 2.0 tools and share their work with their peers. At the same time, the instructor may require all the students in the class to create a wiki of the content area.

To provide support to the learners (i.e., scaffolding), the instructor may insert class discussions, lectures, or instructor-led demonstrations into the learning process. Scaffolding may be especially important for novice learners who may not successfully apply knowledge in relevant contexts, acquire new knowledge when exploring, and reflect on the environment and their activities (Frohberg, Göth, & Schwabe, 2009). It is important to note that if one adopts a

problem-based learning approach, then scaffolding is typically provided after the learner has engaged in a problem, completed an analysis, and formulated a perspective (Duffy & Raymer, 2010a, 2010b). Further, in a problem-based learning approach, the role of the instructor is to understand the students' perspectives and then ask questions to promote critical thinking such as, "What would happen if…How does that relate to…What evidence supports that decision," etc. (Duffy & Raymer, 2010a, 2010b). One interesting Web 2.0 scaffolding tool is scaffold blogging. Students can use iBreadcrumbs to record and annotate search navigations to review with the instructor or peers (Mishra & Koehler, 2009). Instructors also could practice dynamic scaffolding by adjusting their level of support and assistance as learners progress from novices to experts. At the beginning of a learning activity, a novice learner may need detailed instructional materials and numerous student-instructor interactions; however, as the learner acquires knowledge, receives feedback from peers, etc. these scaffolds could be reduced.

If smartphones are used for lifelong learning, then research is especially needed to determine what accounts for learning and how apps are best sequenced for lifelong learning. Further, research is needed to determine how scaffolding would be provided for lifelong learning. Research would need to indicate from whom Army leaders and Soldiers would receive coaching during lifelong learning events (e.g., unit commanders, unit trainers).

**Assessment**

If the Army makes a paradigm shift and uses mobile learning technologies not only in the context of institutional courses but also as lifelong learning tools, then assessment methods would have to change –away from summative assessments (one grade on a final product) and towards formative assessments. Formative assessments more effectively determine the process of change a learner undergoes and are better suited to take advantage of the functionality of smartphones (cf., Vahey & Crawford, 2002). Further, formative assessments often do not result in a grade and would thus require instructors, unit commanders, etc. to provide the type of feedback to leaders and Soldiers that would allow them to identify specific areas of strengths and weaknesses and make changes over time in performance. This type of feedback would be much more useful to leaders and Soldiers after specific courses as they could incorporate it into self-development learning plans. These ideas are supported by the ALC which states that "learner assessments are frequently perfunctory, open-book tests that lack rigor and fail to measure actual learning levels" (US Department of the Army, 2010, p. 3).

"Portfolio [e-portfolio] assessment is an example of formative assessment that has gained wide acceptance as a desired practice – students create a portfolio of their work across many different learning activities which instructors can use to judge the students' strengths and progress" (Vahey & Crawford, 2002, p. 63). In fully utilizing Web 2.0 technologies for learning, students could share their work on the portfolios with their peers and receive feedback. Smartphone technologies afford instructors with the ability to create activities that allow "students to work alone until they are comfortable with their work, then share and explain their work to team members, then cycle back to revising their work autonomously (Vahey & Crawford, 2002, p. 65). When learners publish their work to their peers and self-explain to themselves and others, "learners become aware of their own discrepancies in understanding, enabling them to revise their knowledge" (Rogers & Price, 2008, p. 213). Although prior research reports that instructors used wireless handheld devices for portfolio assessment, an app designed to help instructors collect, organize, and provide feedback on the portfolios would greatly enhance the benefits of this assessment tool (Vahey & Crawford).

Another example of a formative assessment is when the instructor asks the entire class a question (Vahey & Crawford, 2002). Smartphone technology is enhancing the effectiveness of this assessment technique by affording students with the ability to answer the instructor electronically. Apps for class polling aggregate these responses and display them for instructors in graphics so they can get a better understanding of how much the class has learned (there are many reports of this technology being used in large lecture-based classes in universities). To better utilize this technology for student learning, the apps should provide the students with the results so that the student can compare his response to his peers and save it for future reference. For Army training, this type of assessment may be particularly useful during or post AARs (although this type of use is a more summative technique). That is, as platoon AARs are typically conducted in the field out in the open or in a large classroom (for a company AAR), unit leaders / trainers and institutional instructors often do not have the tools on hand to record unit member / student responses to critical questions. Further, as noted previously, unit members / students typically do not have the proper note-taking materials available to record critical performance feedback from the AAR. Smartphone technology would allow students to provide electronic comments to leaders / instructors so that a record of these responses is available for later reference. Army leaders and Soldiers also would have a record of the outcomes of these training events as reference throughout their careers (if smartphones are incorporated into the Army learning model to promote self-development strategies).

Another assessment example, diagnostic testing, could be both a formative and summative assessment technique. For example, interactive apps could be developed which require a learner to first view a person (either a video of a real person or an avatar) performing an incorrect technique and then indicate why the technique was performed incorrectly. This technique also could be used in another way such that learners could be presented with not only the performance of the incorrect technique or a scenario of a leader making a poor decision but also the near- and far-term performance outcomes. The learners first could be asked to reflect on these outcomes and then be presented with a novel scenario in which they would be asked to make decisions regarding the situation. The learners would then reflect on the outcomes of their decisions.

A final formative assessment idea comes from social constructivist theory such that students' potential for learning could be assessed in addition to the products of previous learning (Miller, 1997). Specifically, dynamic assessments may more clearly provide feedback to a learner regarding areas where further work is needed. These types of assessments determine how much improvement a learner can make with the assistance of the instructor. For example, an instructor may provide prompts to the learner to spark further analysis of a problem. If the learner cannot analyze the problem further in response to these prompts then it is clearer to the instructor (and most likely to the learner) the areas in need of improvement.

The use of smartphone technologies as blended learning approaches in institutional courses or as lifelong learning tools requires that a learning management system (LMS) be developed to support the data from the assessments described above. Although LMSs have been developed for private industry, these would likely need to be modified for the Army context. Research is needed to determine which student outcomes should be tracked and how this information is best used for individual and Army purposes.

## Conclusions and Research Questions

- The strengths of smartphone technologies are that they (1) provide the right tools to students at the right time and (2) facilitate learning activities by allowing students to focus on solving the problem rather than on the logistics of completing the activity (Vahey & Crawford, 2002).
- Smartphone technologies may promote problem-based learning instructional strategies reflecting the guidance found in the ALC.
    - However, prior attempts to create problem-based learning POIs within the Army have proven to be extremely difficult to implement due to a resource intensive instructional design process and due to the challenges associated with requiring instructors to change their teaching styles.
    - Smartphone technologies may make designing and implementing problem-based learning and collaborative learning easier and more cost effective.
- Although the present research identified some possible mobile learning approaches for Army training, there are many challenges and research questions that need to be addressed.[3]
    - How can research be designed to determine the effectiveness of mobile learning activities, utilizing smartphone technologies, for Army training?
        - Who are the stakeholders / supporters of this research?
        - Can cost savings be realized by using smartphone technologies in US Army training – both as blended learning and lifelong learning material solutions?
        - Do the benefits of using smartphone technologies for Army training in terms of cost, learning outcomes, etc. surpass those of the current technology (e.g., laptop computers)?
        - Does the use of smartphone technologies in Army training violate the operational fidelity of the training experience if they represent technologies (and software) not available to the Soldiers in the operational environment?
        - How can augmented reality apps be incorporated into Army training? What types of tasks would be effectively trained using these apps?
    - How can training using smartphone technologies be implemented given the constraints of post network security? Will posts support WiFi in designated training areas?
    - How does one determine whether a mobile device is the right tool for a particular learning objective?
        - Which classes are better suited for social interactions via technology?
    - What is the best model for developing apps – especially more complex software such as augmented reality apps?
        - What is a flexible, timely, and effective process for developing and testing apps?
        - How can apps be effectively shared and reused across the Army?
        - How can apps be maintained, updated, and standardized across the Army?
    - Do smartphone technologies overcome past hurdles of using technology in AARs (for a review see Dyer, Wampler, & Blankenbeckler, 2005)? For example, unless trainers continually observe a leader's activity at a computer screen, they may not know exactly what decisions the leader made while utilizing the technology, what messages he read, or how he applied information he received. Could smartphone apps be developed to enable the trainer to flag critical messages and fragmentary

[3] Some of the research questions above were derived from Brown and Metcalf (2008) and Looi et al. (2010).

orders, create meaningful graphs and figures, or display screens in real-time in order to facilitate the AAR?

- Do smartphone technologies provide fundamental changes in the way student learning is assessed or are they just different media for the same methods?
- What types of programs need to be developed to train instructors on how to use the smartphone technologies for learning activities?
  - Does the use of smartphone technologies in Army courses increase instructors' workloads as they monitor both individual and group performance?
- Should smartphone technologies be used during NET to foster a collaborative learning environment?
  - How would instructors receive training to revise current NET POIs to incorporate mobile learning activities using smartphone technologies?
- If smartphones are used for informal learning [self-development], then what are the indicators of learning and what accounts for learning?
  - How are apps sequenced for lifelong learning? What are the sequencing strategies for the use of apps in lifelong learning?
  - How is scaffolding provided for lifelong learning?
  - From whom do Army leaders and Soldiers receive coaching during lifelong learning events? Unit commanders? Unit trainers?
- How do we integrate mobile learning into a LMS?
  - How do we best track/measure information that is sent and received? What, how and how much mobile information do we track? Why track certain information? How do we track impact?
- What are the limitations of using smartphone technologies in learning environments?

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## Appendix A

Acronyms and Abbreviations

| | |
|---|---|
| AAR | after-action-review |
| AIT | advanced individual training |
| ALC | Army Learning Concept |
| app | application |
| COE | current operating environment |
| GPS | Global Positioning System |
| IBL | inquiry-based learning |
| IBOLC | Infantry Officer Basic Leadership Course |
| LMS | learning management system |
| MEDEVAC | medical evacuation |
| MOS | military occupation specialty |
| NET | new equipment training |
| PDA | personal digital assistant |
| PME | professional military education |
| POI | program of instruction |
| SOP | standing operating procedure |
| WiFi | wirelessly via wireless fidelity |